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***Which areas of digital competence are important for a teacher?***

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**1. Introduction**

The main, broad question was specified by some more focused viewpoints that helped to concretize the issue before examining scientific articles for finding elements for the answer. One aim in answering the question was to construct a list of digital competences needed, in general, from teachers and, especially, in supporting the digital competence of students. Another viewpoint was to consider the relationship between teachers' and students' digital competencies: is there a relationship and what is it like, and what can be concluded from that. One more considered aspect was, what aspects of digital competence should be emphasized in different phases of a teacher’s career. Related to that, also the methods for developing teachers' competence through training could be addressed, but since it might be a major task to go into that issue deeply, it was decided to discuss that issue only shortly if relevant publications were found.

**2. Teachers’ digital competences requirements**

A noteworthy result from the reviewing of the research articles is that there were very few studies that examined or discussed teachers' digital competence in a broader meaning of the term (see the question about defining the concept). Most articles focused on teachers' basic information and communication technology (ICT) skills or some special sub-skills. Based on our previous studies we know that teachers’ ICT skills or competence are broadly investigated phenomena, often in order to support practical policy-making and teacher training. It seems that the issue of digital competence has, so far, not been very relevant in research concerning teachers (although in policy related papers, teachers’ competence is a very trendy theme; e.g., in Norwegian national curriculum, digital competence is one of the core competences which is mandatory to take care of in schools; see Krumsvik, 2008).

Some of the examined articles were theoretical papers or articles reviewing other researchers' opinions of teacher competences concerning ICT and digital technology (Kabakçi, 2009; Sabaliauskas, Bukantaité & Pukelis, 2006). Some articles were based on surveys, questionnaires or interviews, unfolding pre-service or in-service teachers' self-reflections of their ICT usage and skills (Aduwa-Ogiegbaen, 2009; Almås & Krumsvik, 2007; Lei, 2009; Rochanansmita, Padilla & Tunhikorn, 2009). Some empirical articles presented a case study where some sub-element of teachers' digital competence, such as information seeking, was examined (Dons, 2008; Graham, 2008; Heldsinger, Smith & Knight, 2007; So & Kim, 2009; Perrault, 2007; Şahin, Çermik & Doğan, 2009; Špernjak & Šorgo, 2009). A few empirical articles examined the participating teachers' ICT competence and usage related to an organized training or development program (Gao, Choy, Wong & Wu, 2009; Juuti, Lavonen, Aksela & Meisalo, 2009; Lavonen, Juuti, Aksela & Meisalo, 2006).

Main viewpoints and results concerning teacher profession and competences in using ICT and digital technology are summarized below.

*Suggested frameworks for teachers' digital competence*

To begin with, a central notion from the review is that the authors of all articles shared the opinion that present and future teachers must be prepared to provide technology-supported learning opportunities for their students and, therefore, need to have adequate ICT skills and digital competence themselves (e.g., Almås & Krumsvik; 2007, Kabakçi, 2009; Krumsvik, 2008; Sabaliauskas, Bukantaité & Pukelis, 2006). In addition, many authors mentioned in their articles the problem that the majority of teachers in their countries still lack or seem to lack necessary skills for using technology effectively at least in their teaching (e.g., Orlando, 2009; Rochanasmita et al., 2009; Špernjak et al., 2009).

Krumsvik (2008) emphasized that specific competence besides the “ordinary” technology competence is required from teachers because the focus of their work is in education and instruction. He defined teachers’ digital competence as “the teacher’s proficiency in using ICT in a professional context with good pedagogic-didactic judgment and his or her awareness of its implications for learning strategies and the digital bildung of pupils” (Krumsvik, 2008). According to him, there is a double dimension in teachers’ competence: they are role models for pupils’ subject use of ICT and they must make educational decisions about how ICT may enhance their learning possibilities, in addition to using ICT for personal purposes.

Four articles provided a broader framework for viewing teacher competences related to digital technology. Almås and Krumsvik (2007) as well as Krumsvik (2008) presented a *Digital literacy model for teachers*, where teachers' competence is defined to include *Basic ICT skills*; *Pedagogic–didactic ICT competence* (an ability to use ICT in teaching subject tin a reflective and well-founded way); *Learning strategies and metacognition* (teachers’ metacognition about their professional development and pedagogical content knowledge, with a special focus on digital competence); and *Digital bildung* (highlighting a strong ethical and moral awareness concerning the usage of ICT). The level of proficiency in these basic aspects is described through the following two dimensions: *Practical proficiency* (Adoption – Adaption – Appropriation – Innovation) and *Self awareness* concerning digital competence(from unaware and incompetent to high awareness).

Kabakçi (2009) proposed a framework for developing teachers' ICT competence. His framework is based on a stage-based model introduced by Mandinach and Cline (1992) presenting teachers' technology use according to the following four stages: Survival stage, Mastery stage, Impact stage, and Innovation stage. In the *Framework of professional development for teachers' ICT use* presented by Kapakçi, four stages for supporting teachers' professional development in each of the above mentioned four developmental stages were defined in the following way:

1. The *Emerging Stage* involves professional development activities addressing technology literacy;
2. The *Applying Stage* includes activities leading teachers to use technology in their teaching practices and enriching their instructional practices through ICT;
3. The *Infusing Stage*, in which teachers' professional development activities should aim at transferring their knowledge and skills into both teaching and administrative dimensions; and
4. The *Transforming Stage* that covers activities that enable teachers to use advanced technology in educational practices to help them become experts and develop new viewpoints.

Kapakçi proposed that the most important aspect in the framework is that teachers should participate in professional development programs according to the stages of technology use, and ICT related activities should be realized in accordance with each teacher's current stage of technology use.

Sabaliauskas and colleagues (2006) made a review of several research publications modelling the ICT competency areas for teachers. Based on the review, they constructed a following list of areas included in teacher ICT competencies:

* Basic ICT competencies,
* Technological ICT competencies,
* ICT policy competencies,
* Competencies in the ethical area of ICT use,
* Competencies of ICT integration into the teaching subject,
* Competencies of didactical methods based on the use of ICT, and
* Competencies of managing teaching/learning process working with ICT.

There seems to be a lot of similarities between these three frameworks. All mention the basic technological skills as well as competences for applying technology in own teaching and for developing their pedagogical practices through ICT further. In two frameworks, also the ethical aspects of technology usage are mentioned.

*Studies of teachers' ICT competence*

In addition to the above mentioned articles discussing teachers' digital competence more broadly, some articles examined teachers' basic ICT skills; the studies were conducted through a survey study. For example, in an investigation of in-service teachers' ICT competence in Nigeria, Aduwa-Ogiegbaen (2009) aggregated teachers' levels of competence in ICT skills into seven key areas: Word processing skills, Spreadsheet skills, Database skills, Electronic presentation skills, Web/Internet navigation skills, Graphic tools skills, and Integration skills.

Lei (2009) studied pre-service teachers from the viewpoint of being "digital natives". The participants of the study assessed their technological proficiency through a list of 51 specific common technologies. Special emphasis in the article was on new web-technologies and classroom technologies. *Proficiency in Web 2.0 technologies* was evaluated by the following categories: Maintaining social networking site, Blogging, Developing wiki, Publishing pictures, Publishing audio files, Publishing video files, Video conferencing, and Developing Web pages. *Proficiency in classroom technologies* was defined to include the following usage categories: Using hand-held and other scientific digital probes, Using interactive whiteboard, Using idea processors, Using software specific to content in areas you plan to teach, Using augmentative systems to help persons with disabilities communicate, Using assistive technology to help persons with disabilities learn.

As part of science teachers’ professional development project, Juuti and colleagues (2009) examined the participants' ways of using ICT for teaching science through to the following technology categories: 1) Simulations and modeling systems; 2) Multimedia, 3) Microcomputer based laboratory; 4) Basic tools (word processing, spreadsheets); 5) Communication applications (e-mail, newsgroups and learning management systems, teachers’ web publishing), and 6) Databases (pupils search information on the Internet). Accordingly, Lavonen and colleagues (2006) evaluated the frequency of science teachers' usage of ICT in science education through the following application categories: 1) Tool applications (word processing, spreadsheets; 2) ICT in learning (computer-assisted learning , computer-assisted research, such as information retrieval, applets and other simulations, or microcomputer-based laboratory tools); 3) Distance learning (email, newsgroup, computer, conference, learning management systems, a teacher making web pages, or students making web pages). Although these category sets were meant for measuring teachers' usage and practices, indirectly they illustrate which ICT competences the authors considered science teachers need in teaching.

Gao and colleagues (2007) investigated pre-service teachers’ process of learning to teach with ICT in a teacher preparation program. They mainly used qualitative data (interviews and observations) and qualitative analysis methods. They did not present any explicit framework for teacher competence in using ICT in teaching, but they emphasized the importance of teachers' positive attitude towards and competence in applying ICT for *student-centered pedagogy* in addition to *teacher-centered use*.

*Examples of singular areas of teachers' digital competence*

Many reviewed articles examined a singular technological skill or competence area that can be considered to be part of digital competence.

Two articles reported studies about some aspect of teachers' online *information literacy competence*. Perrault (2007) made an exploratory study of biology teachers' online information seeking practices. Information seeking proficiency was evaluated through the participants' self-assessment of competence in using the following online tools to find information or resources: Search engines, Specific websites, Digital libraries, Online databases, or Listservs. Şahin and colleagues (2009) made a study about pre-service teachers' usage of a search engine because they considered that teachers who are using these technologies for personal reasons to obtain information will better integrate them in teaching, learning, and curriculum design in the future.

The search engine use was investigated through a questionnaire including problem statements and problem situations identifying whether the participants possessed proficiencies to use the Google search commands. The results revealed that if participants were not oblivious of the most common search commands, they tended to use casual methods in searching, which the researchers assessed to be caused by insufficient knowledge of the virtual environment’s structure and their unawareness of the search commands. In addition, most participants were, e.g., not aware of the advanced search options.

Dons (2008) conducted a case study about pre-service teachers' web-publishing practices and argued them to be an important element in teacher's professional competence for understanding their students' world because digital technology is currently an integral part of the social and cultural practices of children and young people. The participants were interviewed while simultaneously examining their own personal websites. Similarly, Graham (2008) investigated the digital histories and digital lives of young primary school teachers. There was not any list for competence areas provided, but the result presented an interesting categorization of different types of teacher histories concerning digital technology: *The serious solitary self-taught group*, *The serious solitary school-taught group*, and *The playful social group*. The author concluded that opportunities to examine ways in which students and teachers are learning about digital worlds might help teachers understand the digital lives of their students, and might make a contribution to teachers’ conceptions about theories and practices of learning.

So and Kim (2009) used the concept *Technological pedagogical content knowledge (TPCK)* to emphasize that pedagogically sound applications of technology require complex integration of knowledge on content, pedagogy, and technology, rather than seeing them as separate knowledge domains. They applied the following set of criteria to evaluate how pre-service teachers designed ICT based Problem-Based Learning lesson packages:

* *Pedagogical design*: 1) Context / Scenario, 2) Process skill / Tasks, 3) Scaffolding / Supporting materials, and 4) Instructions
* *Technological design*: 1) Incorporation of ICT, 2) Screen organization, 3) Appeal of

display, 4) Continuity / Closure, and 5) Overall technical quality.

According to the results of So and Kim, in technological design the most difficult area for the participants was the incorporation of ICT, especially finding and integrating ICT tools and resources relevant for the target students and learning activities.

Heldsinger and colleagues (2007) investigated a training program where primary school teachers learnt to make digital learning objects, considering it as one competence that prepares pre-service teachers to be ‘workplace ready’ and ‘futures-orientated’. Rochanasmita and colleagues (2009) examined the development of pre-service science teachers' professional knowledge during a training program, and one part of the questionnaire evaluated their knowledge of instructional media and technology. During the training, the participants designed instructional movies and participated in online discussion activities. Based on the analysis of multiple data sources collected during the training, the researchers concluded that the following areas of knowledge of instructional media and technology was enhanced by the course activities: files formats, uploading and downloading, operating software/hardware , creating hyperlinks, conducting internet searches, producing a movie, and emailing and teleconferences.

The study of Špernjak and Šorgo (2009) focused on the competence of biology teachers in applying computer-supported laboratory exercises in science lessons. Laboratory work used by the teachers with pupils was divided into three different types: Classical experiments, Computer experiments, and Interactive simulations. The authors emphasized the importance of using computer-supported laboratories (CSL) in science teaching, and suggested the following three steps in advancing teachers' competences in this area: 1) inform teachers about the suitability and importance of CSL; 2) educate teachers in using such equipment; and 3) help teachers in their efforts to acquire the equipment needed for their classrooms.

*Summary*

All overarching frameworks depicting teachers' digital skills and competence in research literature still seems to concentrate on the conventional usage of digital technology in teaching subject domains. They they did not (yet) include viewpoints concerning the broader conceptualization of *digital competence,* except for the framework of Krumsvik and colleagues, which was connected to situated and participatory models of learning. Similarly, there was not much discussion or elaborated argumentation about the competence that teachers need for being able to educate their students for future. In several articles, however, the technology-pedagogical competence of teachers was emphasized, referring to teachers' ability to apply technology in their pedagogical practices, but mostly in a static and traditional way, demonstrating that digital technologies were not considered as means for more comprehensive transformation of pedagogical practices or educational objectives.

**3. Method for answering the question**

***Search procedures***

The searches were conducted using EBSCOhost, which is an on-line retrieval system of scientific articles related to educational, psychological and behavioral sciences. The searches were targeted to two databases in the system: Academic Search Complete and Education Research Complete. The results from these databases were narrowed down by the following restrictions: Articles were to be peer reviewed, in English, published in between 2005-2010 (originally in between 2000-2010, but due to vast amounts of irrelevant hits this was further restricted) and, finally, the full text was to be available through EBSCOhost with the rights purchased by the University of Helsinki.

The search words and their synonyms used in the process were mainly derived from the vocabulary of the original questions collected from practitioners. In addition to these, some terms were added based on the professional knowledge of the researchers involved in the process.

The process was started with a more general search shared with all the questions related to Digital Competence. This was conducted in order to roughly estimate the workload and to adjust parameters for the search. The search words used in the general search were:

* digital competence\* (all text)
* digital skill\* (all text)
* digital literac\* (all text) AND education (subject terms) AND school (subject terms)
* ICT skill\* (all text) AND education (subject terms) AND school (subject terms)
* ICT competenc\* (all text) AND education (subject terms) AND school (subject terms)
* ICT literac\* (all text) AND education (subject terms) AND school (subject terms)

In addition, the following searches were conducted especially for the present theme, including searches that produced 0 results. The search terms for this set of questions were more complex than most of the terms used for other questions, as the term “teacher” did not restrict the searches enough and produced results that were not humanly possible to handle in scope of the project. The following searches were conducted:

* “ICT skill\*” (all text) AND teacher\* (subject terms) AND requirement\* (all text) AND polic\* (all text)
* “ICT competenc\*” (all text) AND teacher\* (subject terms) AND requirement\* (all text) AND polic\* (all text)
* “ICT literac\*” (all text) AND teacher\* (subject terms) AND requirement\* (all text) AND polic\* (all text)
* “digital literac\*” (all text) AND teacher\* (subject terms) AND requirement\* (all text) AND polic\* (all text)
* “digital literac\*” (all text) AND teacher\* (subject terms) AND demand\* (all text) AND polic\* (all text)
* “ICT literac\*” (all text) AND teacher\* (subject terms) AND demand\* (all text) AND polic\* (all text)
* “ICT competenc\*” (all text) AND teacher\* (subject terms) AND demand\* (all text) AND polic\* (all text)
* “ICT skill\*” (all text) AND teacher\* (subject terms) AND demand\* (all text) AND polic\* (all text)
* “ICT skill\*” (all text) AND teacher\* (subject terms) AND societ\* (all text) AND polic\* (all text)
* Search terms: “ICT competenc\*” (all text) AND teacher\* (subject terms) AND societ\* (all text) AND polic\*(all text)
* “ICT literac\*” (all text) AND teacher\* (subject terms) AND societ\* (all text) AND polic\* (all text)
* “digital literac\*” (all text) AND teacher\* (subject terms) AND societ\* (all text) AND polic\* (all text)

All articles were read carefully and those articles were chosen for the review, which were considered relevant for answering the question. In all, 17 research articles were used in composing the answer.

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